Wireless hopes for universal service in developing countries: an assessment in the Mexican context

José Luis Gómez-Barroso and Arturo Robles-Rovalo

Abstract

Purpose – This paper aims to assess the role that different wireless solutions could have in the universalisation of access to telecommunication services in emerging countries.

Design/methodology/approach – The paper presents a techno-economic model aimed at estimating the cost of deploying and maintaining a wireless network (a 3G network and a CDMA 450 network) capable of providing broadband access. The calculations have been carried out for Mexico, since its socio-demographic disparities represent well the general scenarios of developing economies.

Findings – Wireless technologies are the safest commitment to move forward to universal access in developing countries. The results of this study suggest that provision of broadband in moderately populated zones (suburban and semirural areas) through the deployment of a wireless network could be profitable for those operators willing to invest. Alternatively, these technologies would also be the most efficient option for those governments, which decide to finance the deployment of infrastructures in those regions, which at least in the short term, will not be served by the market.

Originality/value – The paper stimulates the discussion about the role wireless solutions could have in achieving service universalisation in emerging countries. The results may be useful, especially for policy makers, when designing strategies to extend a wireless broadband network access.

Keywords Wireless, Communications, Emerging markets, Developing countries, South America, Mexico

Paper type Research paper

1. Introduction

Wireless communications are revolutionising network expansion, especially in developing countries. Even so, wireless communications are not, as is sometimes suggested with every new development that hits the market, the panacea that will immediately resolve the backwardness of the poorest countries or regions. Despite their deployment costs being significantly lower than those of fixed communications, it is clear that there must exist sufficient demand to make investment profitable.

This is the main objective of this paper: to assess the actual potential of wireless communications for extending access to services in developing countries. In order to give them consistency, the calculations have been made for a real case: Mexico. Given its socio-demographic disparities, Mexico seems to represent an adequate case study. The model assesses the costs resulting from deploying and maintaining a 3G network and a CDMA 450 network, both of them capable of providing data access, although the transmission throughputs considered cannot strictly be considered broadband.

Before reaching this part of the paper, there are two previous sections. Section 2 describes efforts to extend infrastructures in Latin America. Section 3 describes the current situation and the role of mobile communications in this scenario. Following the presentation of the model in section 4, the conclusions close the paper.
2. Efforts to extend networks in Latin America

An “adaptation” of the definition of universal service was made in Latin American countries, where the conditions for telephone service universalisation were obviously quite different from those in developed regions. In 1990, the average in the region was, according to the ITU, only six lines per 100 inhabitants, as opposed to an average 44 in the European Union and 56 in the USA and Canada. In 1995, the figures had grown to nine lines compared with 50 and 61 lines per 100 inhabitants. Additionally, that low number of lines was exclusively concentrated in capital and major cities. In order to develop their infrastructures, the countries of the region devised schemes and mechanisms linked to general sector reform processes and often protected under the universal service umbrella. The strategies included commitments regarding the awarding of licenses or concessions, as well as bilateral agreements generally marked by a limited competition environment. However, the agreements were often broadly breached (Robles-Rovalo et al., 2004). In subsequent stages of the liberalisation process Latin American countries implemented auctions and tenders for awarding specific network extension projects which were financed, in whole or in part, with universal service funds.

Today, these funds exist in most Latin American countries[1]. In some of them, the universal service concept has been formalised more rigorously and universal service obligations have been included in their legislation. Even so, their practical application is usually diluted among vague objectives subject to open interpretations (“as soon as possible”, “isolated sectors of the population”), the lack of secondary legal development or deficient programme management, thus leaving universal service more in the land of good intentions than in that of efficient instruments.

With the new century, the concept of universal service has found its conceptual place inside a broader structure: that offered by programmes for promoting the information society. At the supranational level, the 2000 Florianopolis Declaration[2] announced the intention of the signing governments to enter fully into the information society and, in order to reach this goal, confirmed their need to prepare national basic and advanced service universalisation policies (since “leaving the task” exclusively to the market “could imply risks” basically related to broadening of the digital divide). This declaration was followed in 2001 by the preparation of the so-called Connectivity Agenda for the Americas[3]. Later, in 2003, on the occasion of the Regional Preparatory Conference of the World Summit on the Information Society (WSIS), the Bavaro Declaration[4] was signed. The Bavaro Declaration underlines “the importance of access to new communications and information technologies and the development of specific programmes aiming to reduce the digital divide between countries”. Two years and a half later, in June 2005, the government of Brazil hosted in Rio de Janeiro the Regional Preparatory Conference for the second phase of the WSIS. The final commitment[5] reiterates most of the statements already signed in Bavaro and repeats the commitment of the region to the Millennium Development Goals by confirming the potential of information and communication technologies for their achievement. Maybe more important than this declaration was the approval of a Regional Plan of Action (eLAC 2007)[6] with specific initiatives and activities as well as measurable goals. As was to be expected, the extension of telecommunication infrastructures deserves a chapter in all these plans.

3. Access to telecommunication services in Mexico

The initiatives described in the previous section, but also, without a doubt, the dynamism of the market itself, have led to progress in fixed telephony networks. According to ITU data, penetration, in 2006, in most Latin American countries, lay between ten and 20 lines per 100 inhabitants. In Mexico, it was 18 lines per 100 inhabitants. Processing the more detailed data published by the country’s own statistical services (whose latest values refer to 2004), Table I provides detailed levels of service penetration provided by fixed networks in the different “zones” into which the country has been divided for constructing the model (refer to the following section).

As stated, these data refer exclusively to fixed infrastructures. However, the picture of service access has been radically modified in the last ten years by the accelerated spread of mobile telephony. In Latin America, the number of mobile phones surpassed the number of
fixed lines by 2001, one year before this occurred globally (ITU, 2002). In 2006, the ITU estimated about 250 million mobile subscribers in Latin America, more than twice the 100 million fixed lines existing at the time. Figure 1 shows the evolution of these figures in the last ten years and how mobile telephony has gained ground, representing three out of every four active lines today[7].

More importantly, many of these lines are being purchased by a population segment which previously had no type of access whatsoever. Returning to the Mexican case, Figure 2 shows that the percentage of the population without access to service fell significantly during one year, basically thanks to the dynamism of cellular telephony: during the third quarter of 2005, 25 per cent of the population had no access to service while during the third quarter of 2006 the figure declined to 20 per cent.

What makes wireless communications even more interesting is that they represent a progressively more efficient alternative (which increases as new technological developments hit the market) for data transmission. Mexico, like other countries with a similar socioeconomic situation, faces a double challenge: increasing, indeed, the coverage and deployment of their basic communication networks, but equally, taking the first steps for

<table>
<thead>
<tr>
<th>Zone</th>
<th>Population density (hab/km²)</th>
<th>Population (% of total)</th>
<th>Households with telephone service (%)</th>
<th>Households with telephone and dial-up internet (%)</th>
<th>Households with telephone and broadband (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High dense urban</td>
<td>12,000</td>
<td>26.4</td>
<td>89.2</td>
<td>16.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Dense urban</td>
<td>6,000</td>
<td>21.0</td>
<td>78.5</td>
<td>14.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Urban</td>
<td>1,000</td>
<td>11.7</td>
<td>40.4</td>
<td>7.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Suburban</td>
<td>250</td>
<td>1.9</td>
<td>36.6</td>
<td>6.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Semirural</td>
<td>125</td>
<td>13.7</td>
<td>30.5</td>
<td>5.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Rural</td>
<td>30</td>
<td>8.2</td>
<td>8.4</td>
<td>1.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Isolated rural</td>
<td>12</td>
<td>17.2</td>
<td>3.4</td>
<td>0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>National average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.2</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors based on data from the National Enquiry of household ICT use and availability, 2004 (INEGI, 2004)
generalising access to advanced services which will allow its citizens to join the information society.

Several studies set out the potential mobile networks could have for the provision of broadband in emerging countries. For example, Koanantakool et al. (2004) propose a national initiative for rural wireless broadband access for Thailand suggesting that the evolution of wireless technologies will lead to their selection for providing the service. Gunasekaran and Harmantzis (2007) propose a “strategic wireless framework” for providing broadband to different economic sectors in emerging countries. Tanguturi and Harmantzis (2006) analyse the possible development of a migration to third generation cellular networks in India.

Specifically in Latin America, Mahan (2005) concludes that wireless technologies are the most adequate for extending access “especially for rural connectivity solutions”. Andrade and Conte (2006) study the “technological” steps required for evolution towards 3G in Mexico. The Institute for Connectivity in the Americas (Heise, 2003) suggests the use of wireless technologies in low density areas but does not opt for any specific one. However, none of these studies supports its conclusions by detailed calculations. Assessing the distance that separates the promise from the reality in terms of broadband network extension requires an analysis of the deployment and operation costs associated with wireless technologies. What the market could achieve by itself in extending these networks is a necessary datum for any policy maker preparing any measure leading to the reduction of the digital divide.

4. Assessment of deployment of wireless technologies in Mexico

Using Mexico as a case study, the cost of deploying a mobile network in the whole country is estimated for two different technologies: 3G and CDMA450.

4. Characteristics of the model

The assumptions shared by the two models are:

1. Network planning and dimensioning are carried out following a methodology similar to:
   - 3GAmericas[8], the IST TONIC[9] project and the ITPS study (Forge et al., 2005) for future mobile communications markets and services[10] for 3G technology.
The CDMA Development Group and Ericsson CDMA450 model for CDMA450 technology.

2. Service. A (moderate) nominal 384 kbps downlink bit rate and 144 Kbps uplink bit rate is demanded, which coincides with the wideband class service of the TONIC model used by Welling (2003) and with the proposal of Tanguturi and Harmantzis (2006) for 3G networks.

3. Geographic deployment. The territory to be covered is the whole country. The overall extension is 1,865,000 km² (only the inhabited area of the country, 1,965,000 km², is to be covered). It is considered that a total of seven types of different regions or zones can be identified. This division into zones is based on actual Mexican population, household and demographic dispersion data (used before in Table I). The characteristics of each zone are quite different, ranging from densely populated urban areas to rural isolated ones. This is also the situation in most Latin American countries, making the choice of Mexico representative enough of what occurs in the whole region.

4. Consumer behaviour. It is assumed to be identical regardless of their zone of residence. The demand considered in the model is one connection per household. Given that the number of households in the country is approximately 24 million and the population 104 million, this represents an approximate 25 per cent national penetration (23.1 accesses/100 inhabitants).

4.2 Results

First, the initial equipment, preparation and network deployment investments have been considered (Table II). The designed 3G network departs from a 2G/2.5G core network connected via the mobile switching centre to the radio access network which, in turn, reaches the user equipment. In the case of rural communities, where sometimes there is no core network nearby (>5 km), an additional cost for extending the network link is considered. The CDMA450 architecture is identical to the 3G core and backhaul network. The main difference is the radio access network operation frequency (with the associated changes in the capacity, size and amount of cells) and the price of the equipment. Figure 3 shows the contrasting costs per user.

If network operator expenses are considered for the next seven years, an appropriate period for investment to be recovered (Welling, 2003; Olsen et al., 2006), a raw estimate can be made of the total aggregate investments and it is possible to calculate the expense levels for users in the next few years (see Table III). The figures provided are in US dollars.

5. Conclusions

The monthly cost per user shows that, even in an optimistic scenario, assuming a relatively high penetration for the rural regions (25 per cent of the population, that is, 100 per cent of the households), the cost per user of the isolated zones with low population density is exceedingly high. A user from an isolated rural zone needs an average monthly outlay of

<table>
<thead>
<tr>
<th>Table II</th>
<th>Initial cost per user in Mexico</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>3G (Total investment ( × 1,000)</td>
</tr>
<tr>
<td>High dense urban</td>
<td>2,344,560</td>
</tr>
<tr>
<td>Dense urban</td>
<td>2,718,800</td>
</tr>
<tr>
<td>Urban</td>
<td>2,313,538</td>
</tr>
<tr>
<td>Suburban</td>
<td>272,575</td>
</tr>
<tr>
<td>Semirural</td>
<td>2,931,939</td>
</tr>
<tr>
<td>Rural</td>
<td>6,362,492</td>
</tr>
<tr>
<td>Isolated rural</td>
<td>19,884,591</td>
</tr>
<tr>
<td>National</td>
<td>1,547</td>
</tr>
</tbody>
</table>

Notes: All figures are provided in US dollars.
104-118 USD during the whole period of seven years just to recover the investment. On the other hand, the monthly cost per user required for recovering the investment in the urban (A, B and C) and suburban (D and E) zones is relatively low (between 10 and 20 USD) and can be affordable for an important part of the population in that area[11].

The implications of the results depend on the economic situation of users. Piedras (2006) shows that Mexican mobile communications users spent (adding voice and data access) an average of 18 USD per month. Considering the update of this figure and the possible inflation of the deploying costs caused by the high demand considered (one connection per household), this suggests that, in general and on the given assumptions, the urban and suburban zones could be profitable (or, at least, on the verge of profitability) for operators willing to invest. The datum is significant particularly for the Suburban and Semirural[12] zones inhabited by 16 per cent of the population and where, according to Table I, there is no type of broadband access[13]. Additionally, it is foreseen that the concentration of population in urban and suburban regions in Latin America will increase due to migration from rural to urban zones. Specifically, according to the INEGI (2007) data, in Mexico the proportion of population that lived in urban and suburban regions grew two percentage points during a six year period (2000-2006).

It is obvious that the conclusion is not the same for rural areas. The National Social Development Organisation (SEDESOL, Organismo Nacional de Desarrollo Social) states
that, in 2004, 18 per cent of Mexican households lived under conditions of extreme poverty (income less than 1 USD per person and day, according to the World Bank, that is, approximately USD 130 per month and household[14]); and most of them were located in rural zones. Piedras (2006) also reports that, in the most depressed regions, the total average spending on telecommunications services, where coverage exists, falls to 9.5 USD per month.

Focusing now on comparing the two technologies, the result is that the costs associated with CDMA450 technology are lower than the costs associated to 3G. In any case, it is not advisable to consider exclusively the affordability factor when choosing the network. Despite being the one that requires the highest investment, the 3G network provides the greatest capacity, which allows for future growth in demand, be it in the number of users or in the bandwidth offered.

In summary, wireless networks allowing provision of broadband can help to reduce the access divides in developing countries, at least by taking access to some regions which were devoid of the service to date. Indeed, the results show that, although it will be difficult for the market itself to reach the rural zones in the short or medium term, the potential of wireless networks in moderately populated suburban and semirural zones is notable.

Given that this article is focused on universal service, the fact that the model has not been built for voice-only networks is noteworthy. Although access to voice service is important, as it has long been considered “basic” and still represents the essential content of universal service, it seems that providing voice-only access would only be a first stage in a road that unavoidably leads towards networks where voice would be just another type of data transmitted. In economic terms, taking the two steps at once is much more efficient than taking them one after another. In political terms, if the issue is to provide citizens with tools for their adaptation to the new era, simple access to telephone service is not enough.

In conclusion, wireless technologies are not the balm for all the ailments of the countries or regions devoid of universal service in the short term. However, they do represent the safest commitment for the market to move forward by itself towards service universalisation. They are also the most efficient option for those governments which, in the interest of achieving a truly universal service, decide to finance the deployment of infrastructures in those regions which, at least in the short term, will not be served by the market.

Notes
1. As regards the source of the fund’s resources, only Chile and Mexico have chosen to set it up exclusively with public funds. The remaining countries have chosen a private financing model turning aside a percentage of the operators’ income or a percentage of the taxes they pay to the government for the administrative concessions.
2. Declaration of the government representatives attending the Ministerial Reunion on Information and Communications Technologies held in Florianopolis (Brazil) on June 20 and 21, 2000. It can be found at: www.eclac.cl/publicaciones/secretariaejecutiva/3/1c1383/florianopolis.htm
3. The Connectivity Agenda for the Americas was conceived during the Third Americas Summit held in Quebec (Canada) from 20 to 23 April, 2001. It can be found at: www.summit-americas.org/Documents%20for%20Quebec%20City%20Summit/Quebec/connecting-Span.htm
5. Declaration of the Regional Ministerial Conference for Latin America and the Caribbean, preparatory for the second phase of the World Summit on the Information Society, held in Rio de Janeiro (Brazil) from 8 to 10 June, 2005 (“Rio Commitment”). It can be found at: www.riocmsi.gov.br/espanol/cmsi/documentos/Compromiso_de_Rio_de_Janeiro.pdf
7. Chile and Argentina recorded the highest rates at around 74 per cent and 67 per cent (during 2006) followed closely by Colombia (58 per cent), Ecuador (56 per cent), Brazil (54 per cent) and Mexico (53 per cent) while Peru and Bolivia roughly reached 27 per cent and 25 per cent, respectively.

8. The 3GAmericas is the 3GSM Association section for Latin America. See www.3gamericas.org

9. TONIC (TechnO-ecoNomCs of IP optimised networks and services) is a project within the IST Programme (Information Society Technologies) that concentrates on techno-economic evaluation of new communication networks and services. Wisely and Mitjana (2003) explain in detail the origin and objectives of the TONIC project and prove the financial advantages of using the model. See: www.ist-tonic.org

10. IPTS is the Institute for Prospective Technological Studies at the European Commission’s Joint Research Centre. The study presents alternative socio-economics to estimate potential demand for wireless services. See further study documents at: http://fms.jrc.es/pages/documents.htm

11. According with the IDRC (2005), Latin America’s poorest population spend up to 18 per cent of their monthly income in cellular communications (where available). The IDRC argues that, in many cases, the coverage divide is greater than the economic one. Anyway, it must be underlined that the demand consideration (25 per cent) could be lower depending on the economic conditions of each zone.

12. Zones former rural, nearby Suburban zones (less than 5km), that exceed 100 hab/km due to the migration processes.

13. Satellite services are not considered because they are not affordable for most households.

14. In Mexico there is an average of 4.2 inhabitants per household (INEGI, 2007).

References


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